

CLAIMS

What is claimed is:

1. An active material for use in an electrode in a battery, comprising:
a material that can undergo oxidation-reduction reactions; and
a coating on said material, said coating including one of a conductive agent and a mixture of the conductive agent and a conductive polymeric dispersant.
2. The active material of claim 1, wherein said material comprises one of a metal, a lithium-containing alloy, a sulfur-based compound, compounds that reversibly forms lithium-containing compounds by a reaction with lithium ions, and a lithiated intercalation compound that reversibly intercalate/deintercalate the lithium ions.
3. The active material of claim 2, wherein the metal includes one of lithium, tin, and titanium.
4. The active material of claim 2, wherein the lithium-containing alloy includes one of a lithium/aluminum alloy, a lithium/tin alloy, and a lithium/magnesium alloy.
5. The active material of claim 2, wherein the sulfur-based compound includes one of a sulfur element, Li_2S_n ($n \geq 1$), an organic sulfur compound, and a carbon-sulfur polymer $((\text{C}_2\text{S}_x)_n$ where $x = 2.5$ to 50 and $n \geq 2$).
6. The active material of claim 2, wherein the compound that reversibly forms the lithium-containing compound by the reaction with the lithium ions includes one of a silicon, a titanium nitrate, and a tin oxide.
7. The active material of claim 2, wherein the lithiated intercalation compound includes one of a carbon-based material, a lithium-containing metal oxide, and a lithium-containing chalcogenide compound.
8. The active material of claim 2, wherein the carbon-based material includes one of an amorphous carbon, a crystalline carbon, and a mixture thereof.

9. The active material of claim 2, wherein:

the lithiated intercalation compound includes one of $\text{Li}_x\text{Mn}_{1-y}\text{M}'_y\text{A}_2$, $\text{Li}_x\text{Mn}_{1-y}\text{M}'_y\text{O}_{2-z}\text{X}_z$, $\text{Li}_x\text{Mn}_2\text{O}_{4-z}\text{X}_z$, $\text{Li}_x\text{Mn}_{2-y}\text{M}'_y\text{A}_4$, $\text{Li}_x\text{Co}_{1-y}\text{M}'_y\text{A}_2$, $\text{Li}_x\text{Co}_{1-y}\text{M}'_y\text{O}_{2-z}\text{X}_z$, $\text{Li}_x\text{Ni}_{1-y}\text{M}'_y\text{A}_2$, $\text{Li}_x\text{Ni}_{1-y}\text{M}'_y\text{O}_{2-z}\text{X}_z$, $\text{Li}_x\text{Ni}_{1-y}\text{Co}_y\text{O}_{2-z}\text{X}_z$, $\text{Li}_x\text{Ni}_{1-y-z}\text{Co}_y\text{M}'_z\text{A}_\alpha$, $\text{Li}_x\text{Ni}_{1-y-z}\text{Co}_y\text{M}'_z\text{O}_{2-\alpha}\text{X}_\alpha$, $\text{Li}_x\text{Ni}_{1-y-z}\text{Mn}_y\text{M}'_z\text{A}_\alpha$, and $\text{Li}_x\text{Ni}_{1-y-z}\text{Mn}_y\text{M}'_z\text{O}_{2-\alpha}\text{X}_\alpha$;

$0.95 \leq x \leq 1.1$, $0 \leq y \leq 0.5$, $0 \leq z \leq 0.5$, $0 \leq \alpha \leq 2$;

M' is at least one element selected from the group consisting of Al, Ni, Co, Mn, Cr, Fe, Mg, Sr, V, and a rare-earth element;

A is at least one element selected from the group consisting of O, F, S and P; and

X is at least one element selected from the group consisting of F, S and P.

10. The active material of claim 7, wherein an average diameter of the lithium-containing compound is in a range of 1 to 50 μm .

11. The active material of claim 10, wherein the average diameter is in a range of 5 to 20 μm .

12. The active material of claim 11, wherein the average diameter is in a range of 5 to 10 μm .

13. The active material of claim 1, wherein the conductive agent includes one of a carbon-based conductive agent, a graphite-based conductive agent, a metal-based conductive agent, and a metallic compound-based conductive agent.

14. The active material of claim 7, wherein:
the lithium-containing metal oxide and the lithium-containing chalcogenide compounds have one of monoclinic, hexagonal and cubic structures as basic structures.

15. The active material of claim 1, further comprising another coating disposed on said material under said coating, wherein said another coating comprises one of MPO_4 , MSO_4 and MWO_4 in which M is a group element 13.

16. The active material of claim 1, wherein an amount of the conductive agent in said coating is in a range of 0.1 to 10 wt% of said material.

17. The active material of claim 16, wherein the amount of the conductive agent in said coating is in a range of 1 to 4 wt% of said material.

18. The active material of claim 1, wherein an average particle diameter of the conductive agent in said coating is 1 μm or less.

19. The active material of claim 1, wherein the conductive polymeric dispersant is selected from:

- a polyacrylate-based resin,
- a polyethylene oxide,
- a block copolymer of $(\text{EO})_l(\text{PO})_m(\text{EO})_l$ where EO indicates ethylene oxide, PO indicates propylene oxide, and l and m are in the numerical range of 1 to 500,
- a polyvinyl chloride (PVC),
- an acrylonitrile/butadiene/styrene (ABS) polymer,
- an acrylonitrile/styrene/acrylester (ASA) polymer,
- a mixture of the ABS polymer and propylene carbonate,
- a styrene/acrylonitrile (SAN) copolymer, and
- a methylmethacrylate/acrylonitrile/butadiene/styrene (MABS) polymer.

20. The active material of claim 19, wherein an amount of the conductive polymeric dispersant is in a range of 0.1 to 20 wt% of the conductive agent.

21. A battery comprising:
- a positive electrode;
 - a negative electrode; and
 - a separator including an electrolyte disposed between said positive and negative electrode,
- wherein one of said positive electrode and said negative electrode includes:
- a current collector,
 - an active material disposed on the current collector, and
 - a coating coated on the active material and including one of a conductive agent and a mixture of the conductive agent and a conductive polymeric dispersant.

22. An battery of claim 21, wherein the active material comprises one of a metal, a lithium-containing alloy, a sulfur-based compound, compounds that reversibly forms lithium-containing compounds by a reaction with lithium ions, and a lithiated intercalation compound that reversibly intercalate/deintercalate the lithium ions.

23. The battery of claim 22, wherein the active material is the metal and is selected from lithium, tin, and titanium.

24. The battery of claim 22, wherein the active material is the lithium-containing alloy and is selected from a lithium/aluminum alloy, a lithium/tin alloy, and a lithium/magnesium alloy.

25. The battery of claim 22, wherein the active material is the sulfur-based compound and is selected from a sulfur element, Li_2S_n ($n \geq 1$), an organic sulfur compound, and a carbon-sulfur polymer $((\text{C}_2\text{S}_x)_n$ where $x = 2.5$ to 50 and $n \geq 2$).

26. The battery of claim 22, wherein the active material is the compound that reversibly forms the lithium-containing compound by the reaction with the lithium ions and is selected from a silicon, a titanium nitrate, and a tin oxide.

27. The battery of claim 22, wherein the active material is the lithiated intercalation compound and is selected from a carbon-based material, a lithium-containing metal oxide, and a lithium-containing chalcogenide compound.

28. The battery of claim 22, wherein the active material is the carbon-based material and is one of an amorphous carbon, a crystalline carbon, and a mixture thereof.

29. The battery of claim 27, wherein an average diameter of the lithiated intercalation compound is in a range of 1 to $50 \mu\text{m}$.

30. The battery of claim 21, wherein the conductive agent includes one of a carbon-based conductive agent, a graphite-based conductive agent, a metal-based conductive agent and a metallic compound-based conductive agent.

31. The battery of claim 21, wherein an amount of the conductive agent in said coating is in a range of 0.1 to 10 wt% of the active material.

32. The battery of claim 21, wherein an average particle diameter of the conductive agent in the coating is 1 μm or less.

33. The battery of claim 21, wherein the coating is the mixture of the conductive agent and the conductive polymeric dispersant.

34. The battery of claim 33, wherein the conductive polymeric dispersant is selected from

- a polyacrylate-based resin,
- a polyethylene oxide,
- a block copolymer of $(\text{EO})_l(\text{PO})_m(\text{EO})_l$ where EO indicates ethylene oxide, PO indicates propylene oxide, and l and m are in the numerical range of 1 to 500,
- a polyvinyl chloride (PVC),
- an acrylonitrile/butadiene/styrene (ABS) polymer,
- an acrylonitrile/styrene/acrylester (ASA) polymer,
- a mixture of the ABS polymer and propylene carbonate,
- a styrene/acrylonitrile (SAN) copolymer, and
- a methylmethacrylate/acrylonitrile/butadiene/styrene (MABS) polymer.

35. The battery of claim 33, wherein an amount of the conductive polymeric dispersant is in a range of 0.1 to 20 wt% of the conductive agent.

36. A method of manufacturing an active material for use in an electrode, comprising:

- obtaining an active material; and
- coating the active material with a coating including one of a conductive agent and a mixture of the conductive agent and a conductive polymeric dispersant.

37. The method of 36, wherein said coating the active material comprises:
preparing a coating liquid in which the conductive agent, a dispersant, and a surfactant are dispersed in a solvent;

adding the active material to the coating liquid such that the conductive agent is coated onto a surface of the active material; and

heat-treating the coated active material to form the active material including the coating.

38. The method of 36, wherein said coating the active material comprises:
preparing a coating liquid in which a conductive agent and a dispersant are dispersed in a solvent;

mixing the active material with a surfactant-containing suspension;

mixing the coating liquid with the active material-surfactant-containing suspension such that the conductive agent is coated on a surface of the active material; and

heat-treating the coated active material to form the active material including the coating.

39. The method of 36, wherein said coating the active material comprises:
preparing a coating liquid wherein the conductive agent and the conductive polymeric dispersant are dispersed in a solvent to form the mixture of the conductive agent and the conductive polymeric dispersant;

adding the active material to the coating liquid to coat the mixture of the conductive agent and the conductive polymeric dispersant onto a surface of the active material; and
drying the coated active material to form the active material including the coating.

40. The method of claim 36, wherein said coating the active material comprises:
preparing a coating liquid in which a conductive agent and a dispersant are dispersed in a solvent,

preparing a gelatin-containing suspension in which a gelatin is suspended in a solvent;

adding an acid to the gelatin-containing suspension while controlling the pH thereof to 3 to 4;

adding the active material to the gelatin-containing suspension and agitating the resulting suspension;

removing gelatin residue from a surface of the active material to obtain an active material-containing suspension while controlling the pH of the active material-containing suspension to 5 to 8;

mixing the coating liquid with the active material-containing suspension to coat the conductive agent onto the surface of the active material; and

heat-treating the coated active material so that the gelatin disappears.

41. A method of manufacturing an active material for use in an electrode comprising:

- adding the active material and at least one surfactant selected from the group consisting of a phosphate-based surfactant, a sulfate-based surfactant, and a tungsten-based surfactant to an alcohol-based solvent;
- adding a compound of MX_3 , where M is a group 13 element and X is a halogen element, to the active material-containing suspension such that M^{3+} ions form static electricity bonds with the hydrophilic head group of the surfactant,
- filtering the active material with the static electricity bonds;
- baking the filtered active material with the static electricity bonds at a low temperature to form one of a mesoporous MPO_4 , MSO_4 , and MWO_4 coating layer on a surface of the active material.

42. A method of manufacturing a battery, comprising

- obtaining a positive electrode;
- obtaining a negative electrode; and
- combining the positive and negative electrodes separated by a separator having an electrolyte,

wherein at least one of the positive electrode and the negative electrode includes an active material coated with a coating including one of a conductive agent and a mixture of the conductive agent and a conductive polymeric dispersant.

43. The method of 42, further comprising:

- preparing a binder-containing solution wherein a binder is dissolved in a solvent;
- adding the coated active material to the binder-containing solution to prepare a slurry;

and

- coating the slurry onto a current collector and compressing it to thereby obtain the one of the positive electrode and negative electrode including the coated active material.

44. The method of 42, further comprising:

- preparing a coating liquid wherein the conductive agent, the conductive polymeric dispersant and a binder are dispersed in a solvent;

adding the active material to the coating liquid to thereby prepare a slurry where the conductive agent and the conductive polymeric dispersant are coated onto a surface of the active material; and

coating the slurry onto a current collector and compressing it to thereby obtain one of the positive electrode and negative electrode including the coated active material.

45. An active material for use in an electrode in a battery, comprising:
a material that can undergo oxidation-reduction reactions; and
a coating on said material, said coating including a mixture of a conductive agent and a conductive polymeric dispersant, wherein said coating is coated by:

preparing a coating liquid wherein the conductive agent and the conductive polymeric dispersant are dispersed in a solvent to form the mixture of the conductive agent and the conductive polymeric dispersant,

adding the material to the coating liquid to coat the mixture of the conductive agent and the conductive polymeric dispersant onto a surface of the material, and
drying the coated material to form the material including the coating.

46. An active material for use in an electrode in a battery, comprising:
a material that can undergo oxidation-reduction reactions; and
a coating on said material, said coating including a conductive agent, wherein said coating is coated by:

preparing a coating liquid in which the conductive agent and a dispersant are dispersed in a solvent,

preparing a gelatin-containing solution in which a gelatin is dissolved in a solvent,
adding an acid to the gelatin-containing solution while controlling the pH thereof to 3 to 4,

adding the material to the gelatin-containing solution and agitating the resulting solution,

removing gelatin residue from a surface of the material to obtain an active material-containing solution while controlling the pH of the active material-containing solution to 5 to 8,

mixing the coating liquid with the active material-containing solution to coat the conductive agent onto the surface of the active material, and

heat-treating the coated active material so that the gelatin disappears.